ENGINEERING IN REGIONAL DEVELOPMENT:

A Study of the Role of the Engineer in the Development of the Brazilian Northeast

H. S. Dordick

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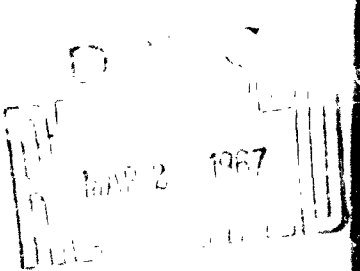

PREFACE

This paper was prepared for a seminar in political science at the University of California, Los Angeles. It was my first encounter with a formal course in political science. The seminar turned out to be a first course in regionalism; hence the rather heavy emphasis on regional concepts. The paper has been revised somewhat for presentation at the forthcoming IDSG Seminar on International Development to be given at the University of Southern California in the spring of 1967.

ENGINEERING IN REGIONAL DEVELOPMENT

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I. INTRODUCTION

In the preface of his book on foreign aid,** Charles Wolf enumerates nine professional disciplines that touch upon this most important subject. It is curious and significant that engineering and the physical sciences are not among them.

Historically, the first attempts at the development of the resources in new and underdeveloped lands have usually been made by entrepreneurs and adventurers, often with a strong engineering bent. The capitalistic wedges, as Furtado*** refers to them, were driven by imaginative entrepreneurs who frequently utilized the most ingenious and advanced techniques from their much more developed countries to capture the mineral wealth of Africa and Latin America. They worked quickly and efficiently and, more often than not, with little regard for the social and economic impact of their efforts on the host country and its people. And as a result of this "entrepreneurship," this practical and pragmatic approach to development for which engineers are noted, they are remembered today as one of the many unfavorable aspects of capitalistic exploitation.

But this rather distasteful association alone is not responsible for the demise of the engineering approach to development. Much more

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**Charles Wolf, Jr., Foreign Aid: Theory and Practice in Southern Asia, Princeton University Press, Princeton, N.J., 1960.

***Celso Furtado, Formação Economico do Brasil, Editoria Fundo de Cultura, Rio de Janeiro, 1959.

important is the fact that the entrepreneurs' engineering works were, in the main, unrelated to the social and economic development needs of the country. Reservoirs with little water to catch in areas where even less is needed, railroads leading from ghost cities and towns to ports long since silted over and mining areas whose future usefulness had been destroyed by hasty but efficient mining procedures; these are the legacies of the first engineering approach to economic development.

In later years, the engineer and the technician were replaced by the more sophisticated development economist. He deals in large scale problems and gross, highly aggregated measures of an entire country's economic, social, and political processes. For him, techniques and technology are just two of the many factors necessary for growth. He considers saving and investment factors, economic sectors and their marginal productivities, and net national products and per capita national incomes. For these are the classical measures of economic health of the more developed countries. But are they meaningful in the new countries of Africa? Or in Brazil where the country is, in reality, split in two? In the South where the bustling cities of Rio de Janeiro and São Paulo are among the fastest growing centers of commerce and industry in the world, such measures are indeed meaningful and useful. But in the impoverished Northeast in the dead and dying villages of the sertão* these measures measure little. When aggregated into the statistics of the entire country they result in confusion and consternation among the economists who are predicting exciting growth rates for the nation as a whole.

A new breed of engineer is now beginning to show interest in the problems of development. He is known by many names--system engineer, operations researcher or analyst, application engineer. But more important, he is attuned to the social as well as economic implications of his technology. And he practices his profession within the framework of regional development. Indeed as this paper proposes to show,

*The sertão is the interior of the country, the hinterland, or backland.

the return of the engineer to a more significant role in economic development is the result of a regional framework and outlook on the development process.

The history of engineering in international development is admirably illustrated by the development problems of the Brazilian Northeast. In this paper we shall trace this story in some detail. First, we shall enumerate and discuss the factors that went into the development of the concept of regionalism in the Northeast, a most important concept since it led to development planning on a regional basis from the very beginning, of itself a most unusual happening. We shall next describe the two faces of economic planning--a story that recounts the rise and fall of the engineer in regional planning. It is also a story of how wonderfully flexible are regional boundaries. Finally, we shall define the role of the engineer in regional planning and show that with his inclusion, a somewhat different, perhaps new, regional concept is defined--a region for implementation as opposed to a region for planning.

II. THE FOUNDATIONS OF REGIONALISM IN THE NORTHEAST

Regionalism implies differentiation in that a region of the country is set aside or recognized as different from other sections, areas, or regions. Thus the New England states have, historically, been classified as a region or, for those purists who attach so many other more subtle values to this word, as a unique section. It was the hotbed of revolutionary fervor and, more than any other area, sparked the American Revolution. It further distinguished itself as the first and foremost manufacturing center of the United States, as an intellectual center; and it finally became an economic problem area in the late thirties and early forties of the twentieth century. There is also a built-in geographic delimitation of the American Northeast. The five New England states occupy a small, rather obvious stub of geography on the American mainland. And there are those who will earnestly vouch for racial and even anthropological differences between New Englanders and other Americans! In the broader context of regionalism, which carries with it a unified endeavor towards some widely accepted area goal, it is rather difficult to define New England regionalism; except perhaps in the Connecticut River Valley, where some form of river basin regionalism has had its ups and downs.

The history of the Brazilian Northeast in terms of defining its separateness is remarkably similar to that of New England.

FOUR CLAIMS TO REGIONALISM

In April of 1500 Pedro Alvares Cabral, on his way to India, and perhaps quite by accident, set foot on the coast of South America in the vicinity of what later became Salvador in the Northeast state of Bahia (see Fig. 1). During the next thirty years or so both the French and the Portuguese frequented the coast of present-day Maranhão, around the Cabo São Roque just north of Natal, and down to Salvador in the state of Bahia in search of the valuable brazilwood (a reddish dyewood resembling a live coal or braza). The southern portion of what is now Brazil was all but ignored by the Portuguese except for the settlement

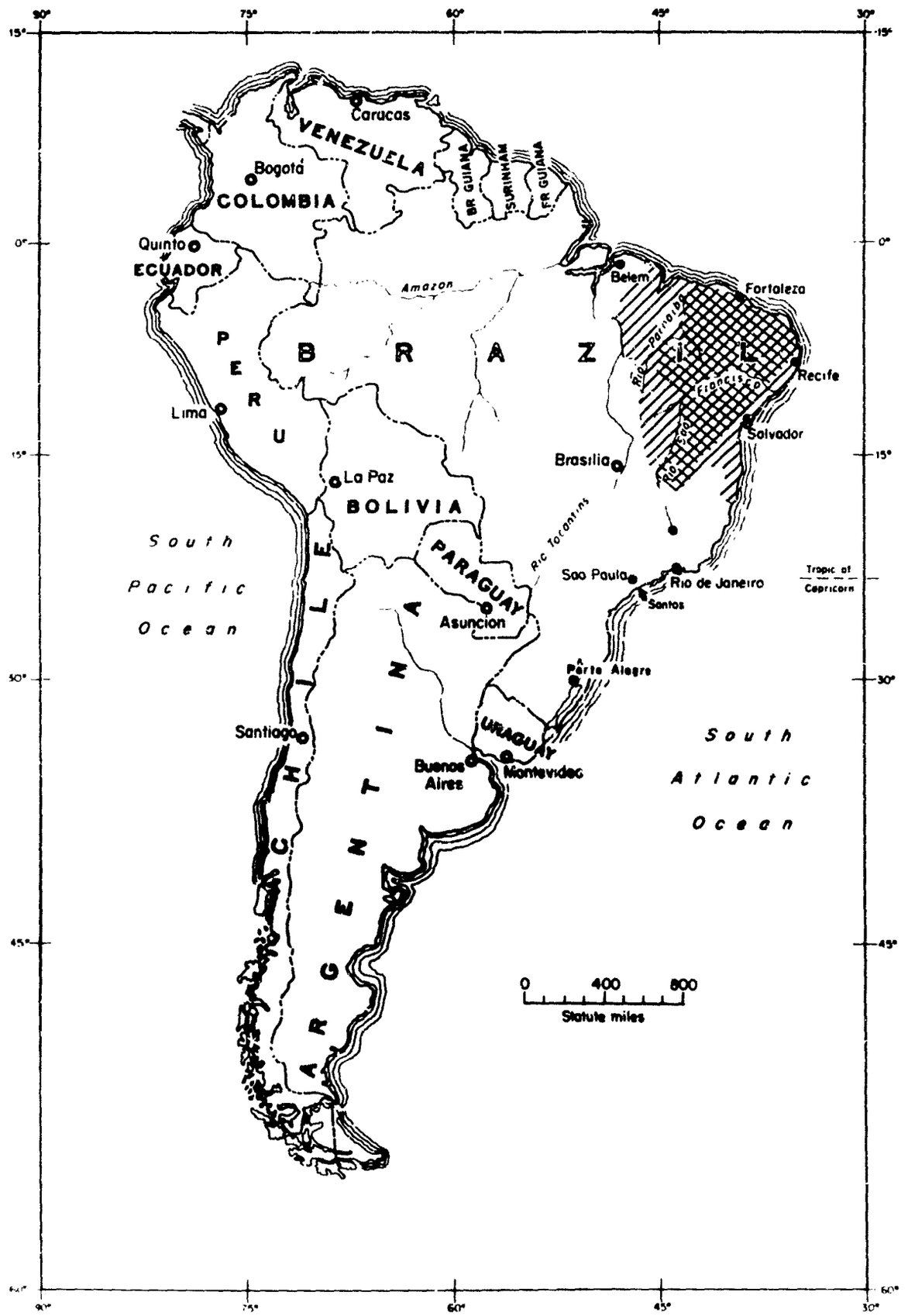

Fig.1 — South America (showing location of drought polygon in the northeastern section of Brazil)

at São Vicente near present-day Santos, which was established in January of 1522 by Martin Afonso de Souza.* The Portuguese were too preoccupied with the Orient to pay much attention to the vast region of South America that the Treaty of Tordesillas had allotted them. But gradually Portugal realized that a treaty alone would not guarantee her this land, and that unless she exerted herself she would lose even those few bases that she had acquired. Furthermore, there were the profits from dyewood, although they were not as attractive as those from the pepper, cloves, muslins, and silks from the Orient. And the dream of an El Dorado still to be discovered in the interior was ever present.

In the 1530s King John III of Portugal, hoping to affirm his country's rights, divided the coast between the Amazon estuary and São Vicente into twelve capitanias. He assigned each capitania to a nominee of the Crown, a donatario, who was granted wide powers and even wider responsibilities. Unlike the Spanish conquistadores, whose major assigned task was to seek, find, and ship the mineral wealth of the land back to Spain, the Portuguese donatarios were expected to settle colonists, promote agriculture and commerce, and defend their territories against all marauders. By 1549 King John III realized that some central authority was necessary. He dispatched a captain-general with a substantial entourage to establish a central government in Bahia, the present-day city of Salvador. Thus the first capital of Brazil was established in the Northeast. The settlers in this area were called upon to expel the French and Dutch intruders who, between 1630 and 1654, had occupied much of the state of Pernambuco just north of Bahia. This provided an historical basis for differentiation and uniqueness of the area, a basis that even today is proudly recalled by the Nordestinos.

Portugal was not a wealthy country in comparison with Spain. Whatever capital resources she had were being directed primarily towards her more productive enterprises in the Orient. Although the "gold mirage"

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*Gilberto Freyre, The Masters and the Slaves, A Study in the Development of Brazilian Civilization, Alfred A. Knopf, New York, 1963. Freyre attaches great importance to this first permanent settlement. To him, Brazil was discovered and founded not by Cabral in the Northeast, who claimed a land, but by de Souza who settled a land.

greatly influenced Portugal's determination to make a strong effort to keep her territories in America, her resources available for investment in Brazil were small.* Portugal had to find a way of economic utilization of her American territories other than the hoped-for easy extraction of precious metals. Were it not for the relatively large scale production of sugar in the Madeira Islands, which the Portuguese had undertaken in order to satisfy the growing European demand, Portugal would never have been able to maintain her position as a great colonial power in the Western Hemisphere. The Portuguese also established a sugar industry along the warm and humid northeastern coast of Brazil, and by the middle of the seventeenth century Northeast Brazil had become one of the world's most important sugar producing areas.** The new colony's great prosperity attracted wealthier people from Portugal and the Madeira Islands who had experience in managing large estates, as well as the complex technical machinery so necessary for a profitable sugar refining enterprise. Although sugar was the major crop, the royal monopoly in brazilwood also prospered, as did the rapidly introduced tobacco, cacao, and cotton. Soon the main labor force of Negro slaves, imported by the thousands from the Portuguese West African colony of Angola, began to swell the Northeast population. Native labor was scarce and the cost of attracting Portuguese workers was high. In any case, the Portuguese mariners had already acquired a thorough knowledge of the African slave traffic. Because of Spain's preoccupation with maintaining its string of isolated settlements in the New World primarily for precious metal exploitation and her failure to integrate her colonies economically with the homeland, Portugal achieved a virtual monopoly in New World agriculture. Thus a second factor, an economic one, further established the Nordestino claim to separateness and began to create a truly regional aspect for this large area. The Brazilian Northeast, albeit only a narrow coastal strip, had become an integral and wealthy part of an empire that for many years dominated the structure of Brazilian society.

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*Celso Furtado, op. cit.

**J. R. Normano, Brazil: A Study of Economic Types, University of North Carolina Press, 1935, pp. 19, 20.

These sugarcane planters were the vertical founders of Brazil in the sense that they rooted themselves deeply in the land. They built large houses of solid stone and brick for themselves and their families, and smaller but equally permanent structures for their slaves.* They built churches and chapels and large sugar mills, and surrounded themselves with as many Old World Portuguese manners and customs as they could export to the rough and crude New World.

There were also the horizontal founders** of Brazil, the migrants who pushed on to the extreme south and north, who went west deep into the jungle in search of gold and slaves for the planters. But it was the more sedentary men of the coasts, and especially those on the large and prosperous plantations of the North, who established an almost feudal social organization--a social status imported from Portugal and encouraged by the rapid growth of the sugar prosperity of Brazil. A unique cultural pattern was developed that contributed and continues to contribute to Brazil what many have considered to be truly Brazilian. The casa grande of the plantations in the North became "even more than the public buildings, symbols of Portuguese power in America."*** From these large and majestic plantations of the Northeast and from those that were established somewhat later in the vicinity of present-day São Paulo and Rio de Janeiro, came those statesmen who became the champions of democratic reform, the first leaders of an independent Brazil, much as many of the statesmen of the American Revolution came from the conolies' Southern plantations.

The similarity between the plantation systems in the United States and in Brazil and their contribution to American and Brazilian independence, respectively, is striking; but it should not be carried too far. The system in Anglo-Saxon America was apparently more rigid from the point of view of race superiority than in Brazil. There was race prejudice between the Portuguese planters and their slaves and a vast social distance between master and slave, between white and black, just as

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*Gilberto Freyre, New World in the Tropics--The Culture of Modern Brazil, Vintage Books, Alfred A. Knopf, New York, 1963, pp. 67, 68.

**Ibid.

***Ibid., pp. 70, 71.

between old and young, man and woman.* However, the Portuguese penchant for "assimilado" resulted in large scale miscegenation with Negro and Indian slaves. And the wars with the French and Dutch did not necessarily result in the complete separation of these nationalities from their Portuguese conquerors in Brazil. There is considerable evidence of a rather distinct racial difference between the Northeasterner and the Southerner in Brazil. For the early Portuguese settlers were, of course, outnumbered in the early settlements. In Bahia, even--more than one hundred years after the initial settlement by the immediate followers of Cabral--there were two thousand whites, four thousand Negroes, and six thousand Indians. Intermarriage and concubinage were accepted as necessary ways of life. As the large plantations grew with the ever greater influx of African slaves, the easy attitude of the church toward "assimilado" soon created a mixture of races both confusing and exciting for sociologists as well as biologists.**

With the movement of the settlers from the coastal strip to the interior, further racial mixture became possible. The more adventurous mulattos and mestizos left the plantations to seek new riches in the interior of the states of Ceará, Maranhão, and Bahia--a geographically and climatically difficult area. This is the arid, drought-ridden sertão or backlands and a unique race of man is found here--the jagunco or sertanejo. Da Cunha*** describes him as an ugly, awkward, stooped, generally unprepossessing individual when not under stress, but once aroused, a fierce, extraordinarily agile horseman of almost dominating aspect.

The Brazilians of the Northeast then, from the arid, semiarid, and coastal parts, constitute a rather distinct regional type. Most of them are or imagine themselves to be the descendants of some Indian brave, even though physically they bear strong European or African evidences. But the very fact that they take great pride in this mixture of races

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*Ibid., p. 82.

**Euclides da Cunha, Rebellion in the Backlands (Os Sertões) translation, The University of Chicago Press, Chicago, Illinois, 1944, pp. 67-79.

***Ibid., pp. 89, 90.

in their bloodstream and frequently hearken back to the glories of their plantation history and its semifeudal cultural and social patterns provides the third and perhaps the strongest psychological and emotional argument in favor of a Northeast region.*

Brazil encompasses a vast geographical area, extending from latitude 33° 45' S to latitude 5° 16' N. Although the prevailing climate is tropical, there are marked differences in climate, as one might well expect in such a large land mass. Along much of the coastal regions there is a rather narrow strip of land backed up by a mountain barrier. Once beyond the cataracts or falls near the coastal mouths of several rivers, water transportation is relatively adequate. But the falls, such as those of Paulo Afonso on the São Francisco, are still hinderances to easy travel and communication in Brazil. Indeed, the major means of transportation and communication between the North and the South has been and still is along the coast--expensive, slow, and certainly not very useful for those living in the interior. This has been another factor in creating a regional outlook in all of Brazil and especially among the people of the Northeast.

THE FINAL CLAIM TO REGIONALISM

At the end of the seventeenth century, the large sugar plantations of the Caribbean islands began to infringe upon the Brazilian sugar profits, primarily because of the declining yield of the depleted Brazilian soils. In the face of such decreasing profits, the Brazilians moved inland in search of new fertile lands and possibly gold and diamonds, which had been discovered in Minas Gerais. Instead they found a vast inland plateau with an average rainfall of less than 16 inches and frequently with no rain at all for several years; they found a land marginally suited to stockbreeding, and land of fierce climatic changes and strange, violent land forms. The natural vegetation was an uneven cover of shrubs with thin, spiny trunks and small gray leaves (the caatinga), as well as many thick-leaved plants, bottletrees, and a wide

*It is of considerable interest to us here that in 1926, a Conference on Regionalism met in Recife, and that earlier, in 1924, a Society for the Defense of Regionalism was founded, also in Recife.

variety of cacti. The land was poor and in general only marginally suited to stock raising. Those few sections, such as the Cariri in the extreme south of the state of Ceará, that have some capacity for agricultural development by virtue of a somewhat larger rainfall, are very overcrowded--in some cases more than 250 persons per square mile.

The harshness of the hinterland and its drought have created poverty and hunger in the Northeast and now force its people to move about from coastal city to coastal city in search of subsistence. During the past 80 to 100 years, their paths have taken them to São Paulo, Rio de Janeiro, to the coffee state of Parana, and to the rich cattle country of Rio Grande do Sul.

Thus, the Nordestinos have established their final and perhaps most powerful claim to separateness, the claim for recognition by the central government as a unique region on the basis of their geography. The combination of geography and history had resulted in the desperate need that the region has experienced; and present-day political practice is to define regions in order to solve problems. Certainly, the economic plight of 30 percent of a nation's population represents a national problem. Motivated by an unusually disastrous drought in 1877, following more than one hundred years of economic decline in the once powerful and rich Northeast, the federal government finally recognized the Northeast sêca or drought as a national problem and initiated a special large scale program of building dams and reservoirs as "works against the drought."*

We have come full circle in describing the regional history of the Northeast and in establishing its claim to regional consideration. The Brazilian Northeast began as the historical and economic pivot of Brazil; it developed a unique culture and even a unique anthropological structure. It carried Brazil through its early history, defended the land and its resources against exploitation, and gave its sons to the nation for the founding of the republic. But the Northeast did not and perhaps could

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*Stefan H. Robock, Brazil's Developing Northeast: A Study of Regional Planning and Foreign Aid, The Brookings Institution, Washington, D.C., 1963.

not respond competitively to the economic pressures both from the South of Brazil and from the new nations of the Caribbean. By the end of the nineteenth century, the Northeast had again become an economic and social focus for Brazil, but this time because it was an underdeveloped region in a developing country, an economic and social burden for a growing country, and therefore the object of economic development planning.

III. THE TWO FACES OF ECONOMIC DEVELOPMENT PLANNING

The sugar economy and its romantic fazenda or plantation society in colonial Brazil crumbled during the last half of the seventeenth century because of external competition and what appeared to be so many other money-making opportunities for Brazilians in their own country. The vast plains of the interior seemed to offer great wealth to cattle breeders. Diamonds were discovered in some remote sections of the sertão, and gold was the exciting word in Minas Gerais. Why fight the Caribbean sugar competition? It was much easier to seek new roads to wealth.

For a while there were two prospering economic systems in the Northeast--sugar and stockbreeding. But as the price of labor increased and the more skillful of the sugar workers sought the riches of the Minas Gerais goldfields, it became increasingly difficult to compete with the Caribbean planters and sugar mills. The sugar industry stagnated, while those who could and wanted to stayed in the Northeast and bred cattle. But the sugar industry is a high productivity one--an industry where per capita output can be high if capital equipment is maintained and improved. Cattle breeding and agriculture are low productivity undertakings. In Furtado's words* a process of "retrograde economic evolution" took place in which an ever growing percentage of the population moved out of a more sophisticated and high productivity sector of the economy into a primitive and low productivity economic sector, almost devoid of the growth potential that technology could provide. The migration of large numbers of people to the semiarid interior of the Northeast made the periodic droughts that hit this region increasingly calamitous.

The Secas. There is an impressive literature describing these tragic periods dating as far back as 1614 when several prospectors moved into the valley of the São Francisco river in search of diamonds.** But it

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*Celso Furtado, op. cit.

**Da Cunha, op. cit., p. 26, cites the following periods of major droughts: 1710-11, 1723-27, 1736-37, 1744-45, 1777-78, 1808-09, 1824-25, 1835-37, 1844-45, and 1877-79. He attempts to show some correspondence between dates of the eighteenth century with those of the nineteenth century. However, recent figures from this century do not correspond at all. These dates are 1900, 1915, 1919-20, 1931-32, 1951-52, 1958, and 1963-65.

was the severe drought of 1877 that caused the Brazilian government to recognize the Northeast secas as a national problem. It was also at about this time that the Brazilians became conscious of the regional aspect of their country and of the rather wide economic disparities that existed between regions. That this was a natural phenomenon, true even in several of the much more developed nations of the world, was undoubtedly recognized by the economists, but state politicians recognized the value to their states, as parts of the region, of emphasizing these disparities. Thus, when national statistics were gathered and published, they were presented in regional terms as early as 1872.

Nine states constitute the region of the Northeast (see Fig. 2). These are Maranhão, Piaui, Ceará, Rio Grande do Norte, Paraiba, Pernambuco, Alagoas, Sergipe, and Bahia.* In this group are, of course, those states that because of political and economic history, cultural and social patterns, and to some extent, geography, would constitute a classic region. But the inclusion of all nine as a Northeast region was primarily a move by the politicians to contrast the backward condition of their area with the fast growing South, a fact worth impressing upon the central government.

The seventy-five year period between 1877 and 1952 represents the era of the classical engineering approach to solving a regional development problem. The problems were water and soil and thousands of studies were made of soil properties throughout the Northeast. For many years large numbers of civil engineers from both military and civilian agencies wandered the region selecting sites for reservoirs and surveying locations for massive dams and hydroelectric facilities. The cost to the central government was high and the political pressure from these nine states heavy. It soon became apparent to federal government authorities that the region as defined did not at all reflect the objectives for

*If the Northeast were a separate nation, it would rank second in population and third in area within South America. Its 25 million population is as great as that of Thailand, more than Argentina, and almost three times the number of people in New England. It is larger than Italy, Spain, and Portugal combined.

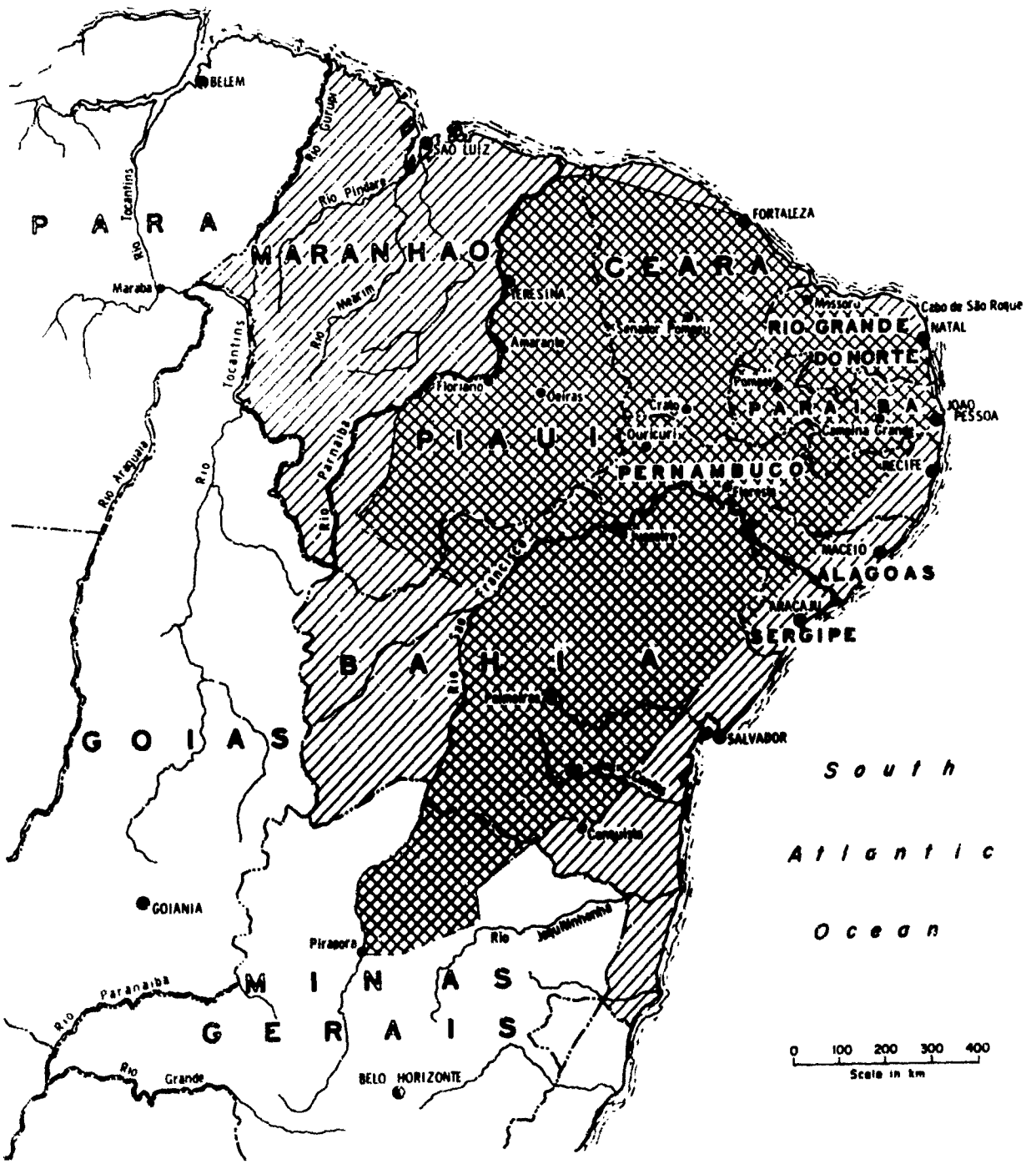

Fig.2—Drought polygon in the Northeast

which the regional definition was made. Not all of the Northeastern states are plagued by the lack of water. The large state of Maranhão has plentiful rainfall. The coastal region from Natal south to the state of Espirito Santo has ample and dependable rainfall averaging over 50 inches per year. A small transition zone between the coast and several miles within the plateau has a fairly reliable rainfall usually between 30 and 40 inches per year. Even the troublesome region--the sertão--has a normal rainfall of 20 to 30 inches but it is highly uncertain and the very nature of the soil prevents much natural storage.

Drought Polygons. In 1936 a drought polygon was defined that included almost all of the states of Ceará and Rio Grande do Norte, small portions of Piaui, Pernambuco, and Bahia. Sergipe and Maranhão were not included. This definition was a realistic one; the true drought area was not a contiguous region but rather isolated pockets of drought-caused poverty. In 1947 and again in 1951, the drought polygon was enlarged due primarily to intense political pressure from states who felt they were not sufficiently included. Once admitted to this new drought polygon they were eligible for public works projects from the drought agency. The newly defined region (see Fig. 2) included almost all of Ceará, all of Piaui, Rio Grande do Norte, Paraiba, and much of Pernambuco, Alagoas, Sergipe, and Bahia. As the National Economic Council points out* this new definition incorrectly magnified the development problem since it imposed a "fight the drought" philosophy upon areas where this was not a major problem. Initially, it was only the sêcas of Ceará that were the main concern; now it was an area about the size of Texas and Oklahoma combined.

The geography and climate of this polygon is extremely varied. Even the problem state of Ceará contains the comparatively verdant Cariri in the extreme south. The São Francisco river runs through the heart of this region, which also contains a large interconnected network of rivers. Although their volume of flow is extremely variable because of the unusual climatology of the region, they are rarely completely dry. There is a wide variety of soils in the polygon, but even

*Conselho Nacional de Economia, "O Problema Nacional das Sêcas," Boletim do DNOCS, Vol. 19, February 1959, p. 10.

with the very preliminary studies now on hand, it appears that except for some small, impossibly saline areas, there is a reasonable prospect for general improvement with better drainage and the proper crop selection and fertilizers.

Despite its name, the drought polygon contains the two major industries of the Northeast, agriculture and cattle raising. Indeed, high quality long-staple tree cotton, which is much in demand, is found within the polygon.

Within the political boundaries of the polygon are the state capital cities of Fortaleza, Natal, João Pessoa, and Teresina. These large urban areas have considerable industrial capacity and are only secondarily affected by the interior droughts. Including these urban areas, the drought polygon as defined by law in 1951 had a population of about 13 million people. The intense drought of 1958, considered to be one of the most severe in several years, affected more than 2 million people or about 10 percent of the total population of the Northeast (including Maranhão). Disastrous as the droughts are, it is clear that they are not uniformly calamitous throughout this artificial region created by a combination of political and natural conditions. The problem in the sertão is not its dryness as much as it is its irregularity of the dry spells and its unique and unfortunate geographic structure. It has little in common with the Chilean or the North American deserts. The people live with a sense of calamity hanging over their heads as do the farmers in Japan or the people of Costa Rica where an impending volcanic eruption can destroy them. But the Japanese and Costa Ricans have, nevertheless, viable economies.

Engineers at Work. Within this artificial framework of the drought polygon the government undertook a vast engineering program of public works. Following the major disaster of 1877 in which a half million inhabitants in the state of Ceará were reported to have died, a British engineer was brought in to study the problem. He recommended the construction of three dams, the largest of which was not completed until 1906. It was poorly constructed and remained quite worthless.

Nevertheless, by 1909, a series of fragmented engineering-oriented commissions were combined into the Inspector of Works Against the Drought whose major duties were and still are to survey the vast region in search of locations for construction projects that would prevent or minimize the effects of drought. The agency has broad powers to construct railroads, dams, bridges, and reservoirs, to drill wells and generally to undertake "other work whose utility against the effects of the droughts has been demonstrated." In 1945, the old Inspector was given a new name, the National Department of Works Against the Drought (DNOCS), and went back to its many construction tasks. An enormous amount of money has been spent. Indeed, in 1934, four percent of the federal tax receipts and four percent of both state and local receipts from the Northeast were to be allocated to these works against the drought.

The engineering efforts were massive. The results were equally impressive. But the magnitude of the task defined by the rather absurd definition of the region was even larger. From 1906 to 1959 reservoirs and dams with a capacity of almost 8 billion cubic meters* were constructed. In the process of performing this impressive engineering feat, significant improvements in railroads and highways were made, for DNOCS frequently needed to ship water to disaster zones. A highway from Fortaleza to Brasilia was constructed, the first interior connection between the Northeast and the South. A radio net of over 65 stations was established and operated by DNOCS for water management purposes. Drought emergency centers dispensing food and medicines were established throughout the polygon. Several small hydroelectric plans with transmission lines were constructed. Many people were employed building roads, reservoirs, and dams.

The Failure of the Engineering Approach. But in the main, this hydraulic engineering approach was a failure. It did not really solve the problems of drought because there really is no way to combat nature on such a large scale. "Works against the drought" are extremely romantic and grandiose objectives especially when one is dealing with an area of over 940,000 square kilometers and a population of over 25 million

*Stefan H. Robock, op. cit., p. 76.

inhabitants. Even if it had been possible to overcome the normal political obstacles which delayed the construction of more dams and reservoirs, even if it had been possible to make optimum use of the natural land formations to maximize the collection of water, physical facilities are not enough to fight natural phenomena. Even today with our knowledge of weather modification as yet not fully proven but nevertheless theoretically possible, it is not theoretically feasible to fight drought in such a vast area as defined by the drought polygon, although a sort of small zone defense might be entirely possible. But this would require political redefinitions, which are quite difficult to bring about.

The truth of the matter is that the objectives were incorrect. The goal is not to fight the drought but rather to find ways of developing the economy. The objectives must be to provide economic opportunity along many lines, to increase per capita income, to increase productivity, and to improve social welfare. With these objectives in mind, it is clear that one of the approaches should be to find other bases for the livelihood of the inhabitants, activities that are not vitally affected by the natural and unpredictable phenomenon of rainfall. With these objectives in mind, defining a region such as the drought polygon would have been unthinkable. But the engineers began their work in the 1880s and at that time the purely engineering approach to development probably seemed appropriate. It is unfortunate that the memory of the tragic events of the drought of 1877 frightened people away from other technological approaches. Nevertheless, by the early 1950s they were ready to try other tacks in their search for economic growth.

Economic Planning on a Grand Scale. In 1951 there occurred another major drought crisis in the Northeast. Thousands of flagelados* resumed their wanderings throughout the region in search of food and a means for survival. Many thousands flocked to the major cities in the South. The failure of the hydraulic engineering approach was driven home both to the people and to the government with striking realism. No longer were the people content to blame the politicians for the mismanagement

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*A local name given to the people affected by the drought.

of construction funds, for it had become clear that there was something basically unsound in the enormous expenditures for the construction of reservoirs that never could contain enough water to service the large areas for which they had been constructed, and in the construction of dams across rivers that later dried up. Besides, there was an alternative to this engineering approach, an alternative espoused by a new breed of technicians trained in economics and ready to give battle to the engineers.

National Economic Planning. As a result of its decision to join the Allies in 1942, Brazil was forced into a period of intense national economic planning in order to fulfill its military commitments. This led to a stronger economic as well as political role for the national government. The dictatorship of Getulio Vargas certainly contributed to this crystallization of national power. And Vargas learned quickly from the numerous American advisors who were sent to Brazil to aid it in its economic mobilization for the war. It was not long after Brazil's entry into World War II that he appointed a Coordinator of Economic Mobilization with vast powers over all states and all regions for directing the economy. By the end of the war, indeed even as early as 1944, Brazil was "sold" on the idea of national economic planning. Numerous visits by Brazilian economists (usually engineers turned economists) to the United States resulted in a large cadre of trained people rather thoroughly imbued with the concept of national planning for development. And, as is characteristic of most Latin Americans, once convinced they move quickly and with great enthusiasm and even greater plans. Even with the downfall of Vargas in 1946 and the usual modifications of the constitution that follow such a political crash, no one questioned the role of the federal government in preparing, financing, and administering long range economic plans.

This had a profound influence upon the Brazilian political regionalists. Although they were now able to look to a more powerful central authority for help, they found that they received much more than mere guidance and advice. The national planning councils were preparing regional development plans and further were actively participating in their management. Inefficient state management of the funds for political gain would now be much more difficult.

When the drought crisis of 1951 hit the Northeast, Vargas, who had won the presidency in 1950, dispatched his Minister of Finance to the Northeast for an on-the-spot inspection prior to releasing emergency funds--a procedure not usually followed by his predecessors. Finance Minister Lafer was more an economist than an engineer and he was extremely critical of the existing programs. Instead of complaints about the drought he was surprised to hear diatribes against poor credit and financing arrangements for farmers, about the lack of credit and about the need for business development rather than new engineering works. "I have the impression," he reported to Vargas, "that in the combat of the sècas up to the present the preoccupation with engineering or hydraulic works frequently overshadows the economic side of the problem."* He added that fighting the sêcas with large scale engineering works would be quite useless unless accompanied by steps to strengthen the regional economy.

The Bank of the Northeast--A Regional Institution. By mid-1951, Lafer, with Vargas' full approval, drafted a most significant law creating the first of many regional institutions for the Northeast, the Bank of the Northeast (BNB). Although the initial purpose of this bank was to make agricultural credit more readily available to the region at a less expensive rate and on longer terms than were available from the national banks in São Paulo or Rio de Janeiro, the BNB soon became the focal point for all major regional economic planning. Under its supervision technical and economic studies of the region were undertaken, economists were trained, and even a small amount of research was undertaken. It set up and coordinated the activities of an Advisory Council consisting of the Director of DNOCS, the Superintendent of the São Francisco Valley Commission (CVSF),** and representatives from each of the eight states included in the drought polygon. The BNB, located in Fortaleza in Ceará, was, in effect, the first truly regional planning institution in the Northeast.

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*Stefan H. Robock, op. cit., p. 92.

**CVSF was established in the late 1940s after a visit by Morris L. Cooke of TVA fame. It is, of course, patterned after the TVA but with the additional objective of populating the interior of the country.

The initial impact of the organization of the BNB, even before actual funds were made available, was a tremendous upsurge in the number of regional institutions in the Northeast. The Latin enthusiasm for grandiose projects reflected itself in newfound wonder of the regional approach to planning. Almost every federal activity in the Northeast, and there were many, became regional authorities. The need for coordination of these many federal, now regional, activities became very evident. There were also numerous state and local organizations that continued to function--organizations that had no clear conception of how they might fit into this new regional structure. But the political stumbling blocks to an effective integration of these local, state, federal, and now regional functions and their associated bureaucracies were overwhelming and quite impossible for the federal government to handle. State and local political interests, although amenable to federal interventions in times of emergency, were not friendly to integrated, regional planning. They had too much to lose.

The BNB economists recognized the highly integrated nature of the numerous plans and projects being espoused and carried out by the many local and state agencies and by the equally numerous federal agencies such as the CHESF* and DNOCS. They struggled valiantly against the political personalities who had so completely ingrained themselves with the Nordestinos. The BNB economists did not wish to exert control, for they had no legal right, but merely to coordinate the local, state, and federal agency activities, so that they could make more efficient use of the money the bank could lend them. Insofar as they could, they imposed a slim sort of regional planning and performance structure in the Northeast by means of financial leverage. But this proved only moderately effective. There was so much "leakage" in public funds, i.e., there were so many other sources for money (DNOCS, CHESF, etc.) that the state or local agencies were not forced to deal with the BNB.

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*Companhia Hydroelectrica do São Francisco (San Francisco Hydroelectric Company).

SUDENE--Superintendency for the Development of the Northeast. Between 1953 and 1959, numerous working groups, study groups, and commissions were established by Vargas and his successors Café Filho and Kubitschek. A Commission on Northeast Investments was created in 1954 within the Ministry of Public Works. It included representatives from thirteen federal agencies and was authorized by presidential decree to coordinate government investments within the drought polygon. In 1956, still another coordinating group, the Working Group for Northeast Development (GTDN), again acting under presidential decree but this time out of the BNB director's office, tried its hand at breaking down the entrenched local and state interests and coordinating regional plans and projects. With no real authority and very little support from President Kubitschek, they had as little success as their predecessors. A nongovernment group under the leadership of the Catholic bishops in the Northeast attempted to provide some coordination, but they, too, failed. However, their failure led directly to the formation of the SUDENE. For the efforts of the Catholic bishops represented as close to a grass roots demand for action as one could muster in a region where illiteracy is as high as 90 percent. The severe drought of 1958 made their grass roots effort a very militant one. Furthermore, 1958 was an election year for many Northeast governors. Kubitschek was forced to pay close attention to the Northeast and fortunately he was able to find a politically astute economist upon whom to thrust the responsibility of a new super-coordinating body for the Northeast. Celso Furtado prepared a comprehensive and politically forceful report entitled "A Policy for the Economic Development of the Northeast." In December of 1959, SUDENE was born, and by May of the following year Furtado completed and submitted to Congress a five-year development plan for the Northeast. It was a politically explosive document, for it dealt straightforwardly with the political as well as the economic problems of regional development. Eighteen months later, in December of 1961, it was finally approved by Congress.

Furtado is a highly respected theoretical economist. It came, therefore as quite a shock to the politicians in Rio to find him an extremely astute politician. For he firmly believed that economic planning on the

grand scale required for a region the size and scope of the Northeast is a political activity. The problems experienced by the BNB and the numerous commissions and working groups clearly showed that until the political hegemony of the Northeast governors and senators was successfully broken or pacified, no meaningful regional planning could take place. They and the heads of the numerous federal and state agencies that had been built up during the 85 years since "works against the drought" began in 1877 were unwilling to give up their control over the allocation of federal funds in the region. Their status within the region was much too valuable to give up. Lilienthal* stresses this point as being one of the major problems he had had in his TVA experience and it is very likely that these are the prime reasons why the TVA idea has not spread elsewhere. Lilienthal was able to work his wonders in the TVA primarily because he had the powerful backing of President Roosevelt. Furtado had cabinet status, but very little political support from Kubitschek, Quadros, or Goulart. In place of this lagging presidential support, Furtado turned to the state governors in the Northeast, the federal legislators from both the Northeast and the South, universities, and the United States foreign aid program. He provided the state governors with a deliberative council through which they could exercise some control over the federal activities in the region. He convinced the Southern senators that support for SUDENE was in their interest since it would, eventually, reduce immigration into their districts, thus easing the social and economic pressures that could endanger their political careers. University groups, especially the students, were inspired by the revolutionary cause of national growth through regional development. The United States, concerned by the Peasant League activities in the Northeast and the ever present memory of Castro in Cuba, supported SUDENE primarily because it gave the United States a convenient focal point for its aid.

The Failure of Macroeconomic Planning. The SUDENE regional planning philosophy is an exercise in political economics and large scale planning. Its objectives are distinctly regional in scope, since it concentrates

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*David E. Lilienthal, TVA; Democracy on the March, Pocket Books, Inc., 1945.

on methods of bringing the Northeast into economic equity with the other regions in the nation. Furtado found powerful support in the National statistics for his claim that the Northeast was far behind the rest of the country in per capita income and was, more importantly, not catching up but falling further behind. He claimed that although disparities between regions are natural and not necessarily dangerous, a widening gap between two regions could eventually result in the establishment of two separate economic systems. Thus, he quietly reminded the nation's leaders of the old threat of national separation, with which Nordestino extremists had frequently threatened the national government.

Furtado stressed the difference between the Northeast and the South and argued strongly for differentiated tax policies. It certainly made little sense to use identical fiscal policies for regions that were economically so different. Industrialization in the South had "taken off" to use Rostow's phrase,* while the Northeast had not yet fulfilled the preconditions for this takeoff.

The SUDENE action plan was threefold: (1) intensify industrial investments in order to increase regional employment opportunities and provide economic opportunities other than those susceptible to the periodic drought, (2) increase agricultural productivity by reorganizing the land ownership structure and utilizing more modern agricultural methods, and (3) relocating population surpluses. This last plan was of particular interest to regionalists since it recommended redefining the region of the Northeast to include the state of Maranhão so as to be able to provide it with federal funds with which to absorb the emigrants from the sertão.

To date, progress has been slow. Action on plans to achieve these grand and ill-defined objectives are undertaken only after considerable political hurdles are overcome. And SUDENE has, unfortunately, continued to combat local and state politicians. Unlike the TVA, SUDENE demanded and received authority over all existing local, state, and federal agencies in the region. Unlike the TVA, SUDENE did not involve these agencies in its master planning, but performed all the planning from above. In retrospect this might have been necessary in order to break down the oppressive

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*Walt W. Rostow, The Stages of Economic Growth, Cambridge, 1964.

political influence of the bureaucrats. Besides, it was evident from their past performance that they were not technically competent to perform this planning. Nevertheless, it would have been politic to bring even the nontechnical people into the planning process, to make them feel committed to and responsible for the evolving plans. Furthermore, in an underdeveloped area, the task of finding competent persons and preparing and training them for effective use is of prime importance. In the process of this training, one can obtain broad regional participation. This SUDENE has not yet succeeded in accomplishing. Note again the difference between SUDENE and TVA.

Today SUDENE is fighting for survival. It has so far not succeeded in providing a spectacular demonstration of the results of its planning philosophy. This is a most necessary requirement for the achievement of any long range regional objectives. But the "political-economic" nature of its approach and its conscious exclusion of any aspect of engineering makes the achievement of this demonstration most difficult. The political desirability, even the psychological desirability, for both BNB and SUDENE to dissociate themselves from any vestige of the old hydraulic engineering approach was important at the early stages of the program. Yet this split has obviously lasted too long. Both BNB and SUDENE have proved their point--that engineering by itself was not a feasible strategy for regional development. But in doing so they have also clearly shown that macroeconomic planning with all its political and social nuances is not by itself a feasible strategy for regional development. Developing nations do not have the time or patience to await the normal churning of the socio-economic process to lift them into higher economic levels. The people must see results and participate in the process. Why has this been so difficult in the Northeast? Indeed, why is it so difficult in other developing countries for which macroeconomic plans have been so hopefully developed?

I suggest that there are two reasons for this. First, for maximum participation of the grass roots, microregions rather than macroregions are necessary. And, second, for providing the practical demonstration so necessary for both the immediate and permanent acceptance of regional plans for development, engineers and engineering are useful, important, and necessary.

IV. REGIONALISM AND ENGINEERING

"Applied science can be the most powerful force in the world for raising living standards if actions can be taken to harness it for that purpose--if the governments and people of the world can find the means and the will."* Applied science and technological know-how are the key ideas with which the engineer is concerned in regional development planning. Improvement of the economic status of an underdeveloped country depends greatly upon how quickly and how effectively it can absorb and adapt technology. And the success of regional development efforts will depend to a large extent upon how well the technological know-how of the most advanced nations can be transferred to the developing country. In many of the lesser developed countries of the world, a great many problems are susceptible to solution most effectively through wise adaptations of foreign developments. Indeed, even in many countries considered to be in the middle range of economic development, a more utilitarian outlook toward research and a much greater stress on the application of both foreign and homegrown developments is apparently required for optimal economic growth.**

The language of the economist, and in particular the development economist, is liberally interlaced with the notion of technological progress and its importance to economic development. Economic theory has rather thoroughly explored the relationship between the accumulation of capital and technological progress, although just how one depends upon the other is not too clearly understood. Certainly one could accumulate just so much capital if technological progress did not provide the means for its investment and use. On the other hand, technological progress without the accumulation of capital is quite impossible. Economic development planners must find the most appropriate means to enter this loop. They must find the development capital and determine how best to introduce it into the development structure. They must also

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*U Thant in the foreword to Report on the United Nations Conference on the Application of Science and Technology for the Benefit of the Less Developed Areas, United Nations, New York, 1963.

**"Israel Worries About Its Applied Research," Science, Vol. 147, No. 3662, 5 March 1965, pp. 1123-1130.

select and introduce in an efficient manner the technologies most suitable for accelerating economic growth. For the growth of an economy is to a large extent a matter of accumulating new scientific knowledge and of advancing the technological application of such knowledge. For underdeveloped economies, it is a matter of assimilating already existing but appropriate techniques.

The classic role of the engineer is to translate ideas and technical knowledge into realities in an economic fashion. The engineer must recognize and understand the need, formulate sound operational requirements, seek possible and appropriate means of satisfying this need (devise potentially useful alternative solutions), and then, combining technical knowledge, experience, and environmental as well as economic and social considerations through sound analysis, determine a preferred solution that will satisfy the need (point out a preferred course of action).

In today's technological world, this defines the system engineer. In the highest sense he is a generalist, fully aware of the economic, social, and even political impact of his technological work. Yet his expertise has usually grown out of some specific base technology. Since World War II, the face of engineering has changed considerably. The technical specialist, the radio or radar engineer, soon found that he was not designing a piece of equipment but rather a system, and as a system it had to be integrated with some operational environment. This operational environment consisted of human, economic, political, and social constraints. In order for his work to be acceptable, it was necessary for him to reflect in his design these nonengineering constraints. The practice of system engineering requires the appreciation of many other fields of knowledge. This fact is reflected by the ever-increasing number of engineers who find themselves working closely with economists, political scientists, psychologists, and physicians.

Application Engineering. Providing technological aid to underdeveloped countries is essentially an application engineering problem, but within a system or regional framework. There is a need for the imaginative application of past experience and proven knowledge to unique and frequently primitive problem situations. The engineer or

analyst is, however, concerned with broader implications than those within a single plant and industry. He is concerned with the translation or application of previously proven techniques, procedures, or products to new and frequently unusual uses in an environment that could be vastly different from that of the initial application. He must question whether or not the economy of the region can bear the cost of the application engineering necessary for the successful transfer of technology. Has he determined what the real need is by a fresh analysis that considers all pertinent factors, or is he satisfying what his previous technical background construes the need to be? For example, given a requirement for some quantity of steel for major construction, an American engineer could very unwisely propose the construction and operation of an automated steel mill à la U.S. practice. But perhaps a concurrent and equally important need exists for finding useful employment for large numbers of people. A more satisfying solution might be to provide initially either a mill with little mechanization, thus providing employment opportunities for many people, or even more primitively, a backyard furnace approach such as had been implemented in Red China. If time is important, the optimal strategy might be to import the steel required for the first construction project and then to utilize the output from the mill or from the backyard furnace for subsequent building requirements. Each of these facets requires consideration by the system or development engineer.

If there is, for example, a need in a very primitive area for lifting water, the obvious solution might be the use of pumps driven by electric motors or gasoline engines. But the trained and perceptive application engineer would recognize that the problem was one of lifting water rather than pumping water, and that the use of complex devices in areas where spare parts and trained technicians are not readily available might be most inefficient. The prudent economic application might very well be an adaptation of Archimedes screw or some similar simple technique involving a low level of technical sophistication.*

*An excellent example of imaginative application engineering is described in RAND P-3367, A Simple Heat Engine of Possible Utility in Primitive Environments, by R. B. Murrow, August 1966.

The application (or system) engineer is also conscious of the social implication of his technology. For if the technology is difficult to use, or represents a sharp break with tradition, it will not be readily adapted. How a device works is not as important as how it is used. The physical theory of solar cell operation is of little importance to the user. What does matter to him is that it gives off power, requires no maintenance or servicing, is safe, and is very reliable. There is perhaps no better example of the adaptation of socially adaptable technology than the introduction of small motors and kerosene lamps to the Japanese cottage industries early in this century. It required essentially no change in their way of life or their way of earning their living, but nevertheless substantially increased their productivity.

The application engineer is strongly motivated towards the use of off-the-shelf components. One measure of his success is how imaginatively he can apply known solutions to new problems. Other measures are his ability to relate his own and others' experience to the problem on hand with all its environmental constraints, and his ability to seek out applicable information. He is trained to avoid experimentation with new concepts. He is extremely cost conscious. And he is very quick to understand and appreciate a customer's hidden as well as stated problems. It is, however, not necessarily good for him to be "expert" in the specific problem area. He should be, rather, familiar with the environment (people and places) into which he will have to transplant new technology. His technical background should be broad and basic rather than narrow and highly specialized.

There is a striking similarity between the concepts of system engineering as described here and the concepts of regionalism. Both concepts developed out of the need to more fully relate a single discipline to those neighboring disciplines upon which it impacts. Thus a political scientist or public administrator tackling a regional planning problem would soon find himself involved in problems of economics, sociology, geography, history, ecology, and of course engineering. For it is only with this broadened and more encompassing view, whether it be called a system or a regional view, that the most effective impact of the specialist's work can be realized.

The Region for Implementation

Demonstration for Impact. It is not our intent here to imply that on a macroregional development scale such as the Brazilian Northeast, there is no role for the engineer. On the contrary, he is most important if the development plans include, for example, large scale hydroelectric works such as the TVA, mass transportation, or communication systems. But an important requirement early in the development program is the demonstration that will have an immediate and powerful impact on the people--especially if they participate in the preparation for and operation of the demonstration. It has been seen that in the Brazilian Northeast, large scale efforts such as 85 years of hydraulic public works have been quite ineffectual and have served more to discredit the development program than to popularize it. The engineers could not point to a truly successful demonstration of the usefulness of the hydraulic system. Even the massive and impressive hydroelectric plant at the Paulo Afonso Falls has failed to impress the people in the drought polygon, primarily because they do not know how to use electric power fruitfully and there have been few programs such as industrialization that can demonstrate the worth of electric power. Indeed, most of the power from this installation is used by the major cities of the Northeast and along the coast that are not included in the polygon. Had the development program required the implementation of many simultaneous projects for the accomplishment of many objectives, there could now have been several agrico-industrial centers in existence that could economically use the power from this plant. In short, a multipurpose region must be defined.

In the drought polygon there are numerous such areas that could lend themselves to such a definition. But the first task is to rid the planners of the notion that the region must always be completely safe from drought. A more likely region would be one that could become a strong agrico-industrial area where there are sufficient natural resources even of a marginal quality, sufficient human resources even if untrained, and a sufficient number of people to provide a market for the goods produced. The Cariri region in the south of the state of

Ceará is just this sort of "well balanced" region that could lend itself to integrated agrico-industrial development.

The Example of the Cariri. Here is a region about the size of Los Angeles County, bounded on two sides by rivers--the Cariri, which more frequently than not is dry, and the Jaguaribe, dry only a bit less frequently. It has a population of about a half million inhabitants and is made up of a number of small (fewer than 10,000 inhabitants) towns surrounded by a hinterland region of the usual difficult-to-farm lands where most of the people eke out their living. There are, however, three large cities (between 20,000 and 50,000 people)--Crato, Barbalha, and Juazeiro do Norte--which are recognized as the commercial centers of the region. It is also in these cities that the more prosperous farmers and cattle breeders live, as is evidenced by the several rather luxurious homes seen there. In short, it is a region whose economy is precariously based upon agriculture, but is just a bit above the subsistence level primarily because there is always some water.

The Cariri is one of several regions that the U.S. AID Rural Industrial Technical Assistance program, in cooperation with several American universities and their Brazilian counterparts, has selected for pioneering experimentation with activities or strategies for encouraging local entrepreneurs to form and subscribe to locally owned open stock corporations. These experiments are extremely transparent in the sense that all the trials and tribulations of building up the notions and attitudes of entrepreneurship and private initiative are very much in the open.

The technological and engineering problems that these new industries face are very much exposed. It may very well be that in several cases the processes are too complex and labor not intensive enough to satisfy the variety of goals for which they have been established. The economic scale of the process and technology that is being adapted might be somewhat higher than one might want if more realistic goals had been established. It is even at this early stage in the development process these "laboratories" have begun to point up the need for the development of [illegible] regional development. Although it is felt that the conclusions [illegible] drawn apply to other development goals, we shall here [illegible] primarily industrial development.

A Role for the Engineer in Regional Development

A major problem facing the would-be industrial developer in the Cariri as well as other underdeveloped areas of the world is his lack of design experience. There is a lack of basic design and application information. There is a lack of the necessary skills to integrate the two in many, if not all, of the regions that are at the stage where they seek to industrialize.

We are using the word "design" in its broadest definition. In this sense design refers not only to the creation of product configurations, but also to process design, to plant design, to management information and control system design, to financial and credit system design, and to the design of distribution systems.

At least in the Cariri it has been shown that capital for small and medium industrial projects can frequently be raised within the region. Certainly, labor is available even if this labor is initially not well suited to the level of industrialization found desirable for the region. The catalyst that appears to be necessary for getting all these good intentions moving towards some meaningful goal is the ability to conceive and design products, processes, and plants and their supporting systems. These design packages must be custom tailored from the beginning for the regional environment in which they are to be applied. But this is time-consuming and expensive. Hence the notion of design packages has been suggested that could possibly be ready-made or at least to some extent standardized for a range of physical and human environments.

There would be a product design package that might very well be the least standard of all. For it would be most responsive to the markets in and around the region. But nevertheless it is conceivable that among regions such products as radios, shoes, processed foods, small power generators, pumps, clothing, and furnishings could be modularized and standardized at least sufficiently well enough to be able to satisfy the quality requirements placed upon them because of the environment and cost.

There would be a process design package that must be integrated with the plant design package. It appears reasonable to assume that

a higher degree of standardization could be achieved at this level. The major rationale for this standardization is to enable one to reduce the time from the initial investment to initial production. It is desirable that this be as short as possible in order to take greatest advantage of the demonstration effect of the program so necessary in the developing countries.

Very closely allied to the plant and process design packages is the management information and control package. This design may range from simple paper work flow control to some elementary mechanized data handling equipment--whatever is required by the size of the plant and the sophistication of the management. Generally speaking, it is in the management and administrative areas that there is a shortage of skills and that a somewhat higher level of mechanization might prove extremely valuable by reducing the number of high level skill requirements. The management information and control package must of necessity be tailored to the application, probably much more specifically than any of the other packages.

It is not usual to speak of a financial and credit system package but in the framework of this discussion it may be useful. For each regional plan may have unique financial and credit constraints. But nevertheless they will require some integrated and efficient handling so that the enthusiasm of the investors is not dissipated in a morass of legal and bureaucratic paper work. This is not to say that merely thinking of this problem area in terms of a "design package" will remove these painful machinations. But if one can focus on these efforts as a specific task for a specific person in the design team, it is possible that only he will be plagued by the bureaucracy and things may move a bit faster and in a more orderly fashion.

Finally, there is the distribution system package--for example, transportation. This function is in the main interregional and possibly cannot be handled as a part of the individual plant or industry design package. More probably it must be handled by the state or federal authorities. But if the package for a specific industry or complex is designed, it can then be submitted to the state or federal authorities for consideration in their interregional planning.

Perhaps what has been described here is the role of the engineer in the demonstration region. For we have defined yet another region. We have defined a region in which it is technologically feasible to utilize its total resources, material, human, and financial, for the performance within a reasonable time of development actions. A region suitable for regional implementation rather than regional planning has been defined. For with this region, objectives and the specific means for achieving them become more understandable and visible. Furthermore, it enables one to implement at the grass roots level that which is so important for achieving meaningful and lasting social change.

Is there a scale limitation to this region? I think not. For in time these regions for implementation can be interconnected and combined into larger economic structures. The role of engineers and engineering is continuous. But when included as it should be among the disciplines that must contribute to regional planning for economic development, it will result in more realistic definitions of regions for action or implementation. In the end, the development process will be accelerated, the important demonstration projects, which the SUDENE now needs so desperately, will be completed, and the first difficult step toward "regional equity" will have been taken.